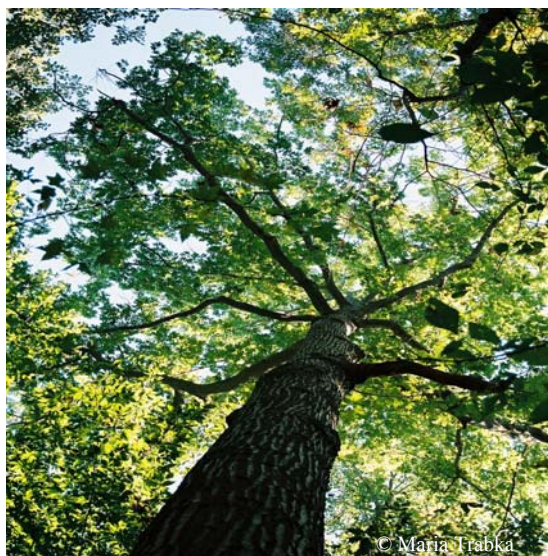


# Blackbird-Millington Corridor Conservation Area Plan

## Mixed Hardwood Coastal Matrix Forest

### Target Description

The Corridor's forests constitute one of its most defining features, with over 27,000 acres of the Corridor forested (Map N). Corridor forests include some small pockets of Dry Oak-Heath Forest (dominated by black oak and lowbush blueberry) and Tuliptree Rich Woods (dominated by tuliptree, beech, n. red oak). But the overwhelming majority of these forests are Mesic Coastal Plain Mixed Hardwood Forests -- beech-white oak-tuliptree-sweetgum Forest -- with wet and dry variants.<sup>1</sup> The forest itself is a complex system of diverse and interacting species in the canopy, shrub, herb layer, and soil.



The Mesic Coastal Plain Mixed Hardwood Forests community is generally not dominated by any one species, but rather a mix of oaks, American beech, hickories, tuliptree, and sweetgum, with red maple, blackgum, shadbush and sassafras as frequent canopy or sub-canopy trees. These forests span a range of soil moisture conditions, from dry ridges to low moist areas on the edge of wetlands, which is why this forest type has been separated into wet and dry variants. Wet variants are rarely inundated yet exhibit mottling within 30 cm of the soil surface, indicating hydric conditions (dry variant forests almost never have mottled soils).<sup>2</sup> Each frequently includes a mix of species in the canopy, shrub and herb layer, as detailed in Figure 6. It is important that both dry and wet variants be conserved.

**Figure 6: Wet/Dry Variant Species<sup>3</sup>**

	Wet Variant	Dry Variant
<b>Canopy &amp; Subcanopy</b>	frequently includes pin oak, willow oak, and southern red oak	typically includes pignut hickory, mockernut hickory, black oak, and northern red oak with flowering dogwood, hornbeam and black cherry in the understory
<b>Shrub Layer</b>	Dense with sweet pepperbush typically dominating. Other common woody plants include: highbush blueberry, American holly, wild azalea, and common greenbrier.	May be dense or sparse, but typically includes highbush blueberry, strawberry bush, maple-leaf viburnum, and arrowwood, with glaucous-leaved greenbrier, Virginia creeper and grape vines being common woody vines
<b>Herbaceous Layer</b>	Sparse in cover, but partridgeberry, indian cucumber-root, tree clubmoss, cinnamon fern, and royal fern are common	Tends to have greater species diversity and overall cover. Common herbs include Solomon's seal false Solomon's sea, Indian cucumber-root, partridgeberry, spotted wintergreen Indian pipe, rattlesnake plantain, Swann's sedge, crane fly orchid, and naked-flowered tick-trefoil.

<sup>1</sup> Delaware Natural Community Classification, Bowman 2000.

<sup>2</sup> Bowman, Peter J. and William A. McAvoy. 2002. Forest Habitat Quality Survey of the New Castle County Coastal Plain. Delaware Natural Heritage Program Division of Fish and Wildlife Dept. of Natural Resources and Environmental Control.

<sup>3</sup> Bowman, Peter J., and Christopher M. Heckscher, William A. McAvoy, and Eric F. Zuelke. 2001. Biological Surveys at Blackbird State Forest: 2000 Progress Report. Delaware Natural Heritage Program, Delaware Division of Fish and Wildlife, 4876 Hay Point Landing Road, Smyrna, DE.

In addition to the plant diversity they support, the Corridor's forests are critical for supporting a diversity of mammals, birds, and amphibians. Interior forest areas in the Corridor are important for neotropical migratory songbird species that need or thrive under conditions found in the deep forest. A 2002 survey of Blackbird State Forest identified 75 species of birds.<sup>4</sup> Seven of the top ten most abundant breeding-season birds were neo-tropical migratory birds that rely on the Corridor as a stopover place. Six species of high conservation concern were noted during this survey: Hooded warbler, Brown creeper, Black billed cuckoo, Worm eating warbler, Barred owl, Coopers hawk, Black-crowned Night Heron, and Red shouldered hawk. Perhaps most significant among these observations is the possibility of a viable Hooded warbler population the Corridor. This very rare peninsula-breeding bird is in danger of extirpation from the immediate region.<sup>5</sup>

Other raptors, cavity nesters, and large-tree dependent birds like cooper's hawk, red-tailed hawk, red-bellied woodpecker, and pileated woodpecker rely on the large trees of mature forests and have been noted in the Corridor.<sup>6</sup> And Corridor forests are also particularly important for amphibian species that depend on forests for part of their life cycle, like the frogs and salamanders that breed in nearby coastal plain ponds. Some of these species include: spotted salamander, marbled salamander, eastern tiger salamander, eastern newt, four-toed salamander, northern cricket frog, fowler's toad, cope's grey tree frog, barking tree frog, gray tree frog, spring peeper, New Jersey chorus frog, American bullfrog, green frog, pickerel frog, wood frog, southern leopard frog, and eastern spadefoot toad.<sup>7</sup>

### ***Indicators of A Healthy Mixed Hardwood Coastal Matrix Forest***

The four key attributes selected by Core science team members as those most important to sustained forest health are connectivity (as indicated by forest patch isolation), biological composition and structure (as indicated by forest maturity), species composition and structure (as indicated by oak dominance), and patch size and shape (as indicated by zonal thickness). The analysis surrounding each of these attributes and their indicators is presented below. For maximum habitat value of mixed hardwood coastal matrix forest, The Nature Conservancy and science team members recognized the need for a "minimum dynamic area" of forest -- an area big enough to withstand catastrophic events and support breeding territories. Research by The Nature Conservancy<sup>8</sup> and discussions of Core Science Team members indicate that a minimum dynamic area of 15,000 acres is appropriate for the Corridor. This minimum dynamic area is also built into forest conservation objectives for the Corridor (further described later in this report), the main thrust of which is to build a connected area of 15,000 forested acres that is of good quality according to the forest health measures described below.

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<sup>4</sup> Heckscher, C.M. and K.S. Kalasz. 2003. Forest-Dependent Birds of Blackbird State Forest: Species composition and implications for conservation. *Delmarva Ornithologist* 34:10-22.

<sup>5</sup> Email communication with Christopher M. Heckscher of the Delaware Natural Heritage Program, January 2005.

<sup>6</sup> Heckscher and Kalasz, 2003.

<sup>7</sup> Delaware Natural Heritage Program. Biological Survey Data provided in digital (GIS) format, November 2004. Delaware Division of Fish and Wildlife, 4876 Hay Point Landing Road, Smyrna, DE.

<sup>8</sup> Anderson, Mark. 2004. *Determining the Size of Eastern Forest Reserves*, The Nature Conservancy.

## **Forest Patch Isolation: An Indicator of Forest Connectivity**

One of the key forest attributes identified by Corridor scientists was the connectivity of forests to other forests – an important factor for many of the most important forest-dependent species, especially breeding birds. The indicator that was selected as the best (for effectiveness and practicality) way to measure this connectivity is "forest patch isolation." Forest patch isolation is a measure of the extent to which the areas surrounding any given point are forested, and is expressed as a percentage. One of the advantages of forest patch isolation is that it can be measured via Geographic Information System (GIS) analysis, provided forest cover data is available. Another advantage is that specific values for forest patch isolation within 2 kilometers have been correlated with on-the-ground observances of specific species in the Mid-Atlantic region by researchers.<sup>9</sup>

Forest patch isolation parameters for the Corridor were established based on Corridor surveys and documented results for: brown creeper, for which 82% Forest Cover within 2 kilometers is needed for nesting; red-shouldered hawk (71%); yellow-throated vireo (70%); american redstart (62%); and hooded warbler (59%).<sup>10</sup> Brown creeper has been found in surveys within Blackbird State Forest and there has been one confirmed breeding recorded at the southern periphery of the Corridor study area from the Breeding Bird Atlas/Survey.<sup>11</sup> Red shouldered hawk is a confirmed breeder in the Corridor and yellow throated vireo is a probable breeder with the survey confirming breeding in the vicinity of Taylors corners. The hooded warbler, which prefers a dense shrub layer, was detected at a very low frequency by the Delaware Natural Heritage Program and there was one possible atlas/survey record within the study area, but a potentially viable population of hooded warbler in the Corridor is extremely significant.<sup>12</sup>

These observances, along with the 15,000-acre minimum dynamic area concept, were used to develop the indicator ratings shown in Figure 7 In theory, the 15,000-acre minimum dynamic area would be a solid forest block. Realistically in the Corridor, a less-than- solid but connected block may be the optimal achievable condition.

Rick McCorkle, of the US Fish and Wildlife Service Delaware Bay Estuary Project, conducted the GIS analysis to calculate forest patch isolation values for the Corridor using forest data provided by the Natural Heritage Program.<sup>13</sup> The results were mapped in accordance with established parameters for Poor, Fair, Good, and Very Good as shown in Map O. The darkest green areas represent the highest forest patch isolation results and the therefore the best quality forests *for connectivity*. The Corridor

**Figure 7**

**Forest Patch Isolation Indicator Ratings:**

**Poor:** < 15,000 acres with more than 58% total forest cover within 2 km

**Fair:** at least 15,000 acres 59% or more total forest cover within 2 km

**Good:** at least 15,000 acres with 70% or more total forest cover within 2 km

**Very Good:** at least 15,000 acres with 81% or more total forest cover within 2 km

<sup>9</sup> Robbins, C. S., D. K. Dawson, and B. A. Dowell. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic States. Wildlife Monographs 103. The Wildlife Society, Bethesda, MD. 34 pp.

<sup>10</sup> Robbins et. al. 1989.

<sup>11</sup> Sauer, J. R., J. E. Hines, and J. Fallon. 2004. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2003*. Version 2004.1. [USGS Patuxent Wildlife Research Center](#), Laurel, MD

<sup>12</sup> Email communication with Christopher Heckscher of the Delaware Natural Heritage Program, January 2005.

<sup>13</sup> Data developed by Rob Line and Josh Cohen (DNREC) based on land use/land cover.

currently has 790 acres of forest that qualifies as "Good", with over 5,000 acres "Fair" and the majority of forest areas ranking "Poor" (23,782 acres).

Given the relatively small patch size and high degree of fragmentation of Corridor forest, their poor performance in this measure is not a surprise. Since improving patch isolation can only be accomplished through reforestation, improving this ranking will be a long-term effort. The more important result of this analysis for the short term is that it indicates where the highest quality areas are, so that protection and restoration efforts can be targeted to key areas.

## **Forest Maturity: An Indicator of Forest Biological Composition & Structure**

A second key attribute identified by scientists as critical for Corridor forests is biological composition and structure -- an optimum species mix, age/class structure, and healthy shrub, herb, and duff layers. Without much comprehensive data for forests Corridor-wide, team scientists identified maturity as the most practical indicator for species composition and abundance in Corridor forests. Mature forests are preferred by yellow-throated vireo, northern parula, American redstart, worm-eating warbler, Louisiana waterthrush, Kentucky warbler, hooded warbler and scarlet tanager, among others.<sup>14</sup> All of these species also happen to be sensitive to forest fragmentation, and all occur or have the potential to occur in the Corridor.

Today there is no true old growth (undisturbed for 200 years or more) in the Corridor, as a result of the clearing of forests throughout history and the effects of invasive species (particularly gypsy moth). While science team members agree that some component of true old growth would be ideal for forest quality in the Corridor in the long term, it is not a very relevant indicator for Corridor forest habitat today or the near term. Also, while old growth is important for its rarity, that level of maturity is not necessarily the highest quality habitat for other species important to the Corridor - like forest birds.

Through a process of discussion and site visits, the Core Science team identified a level of maturity thought to provide the characteristics most desired for forest habitat in the Corridor. For today and the near future, this high quality mature forest habitat is defined as: the presence of 100+ yr old trees, a variety of ages and sizes of trees, a mix of native species dominated by oak in the canopy (25% oak), presence of herbaceous and shrub layers in patches/variability, presence of standing dead trees/snags, downed logs and woody debris, thick leaf litter/organic matter in duff, and occasional canopy gaps due to tree fall. In the Blackbird State Forest, the Van Dyke Track was examined as an example where there are 33 acres of this type of habitat. Maturity is just one element of the high quality forest desired, but in this case was chosen as an indicator of the presence of these other features (with the exception of oak

### **Figure 8**

#### **Maturity Indicator Ratings:**

**Poor:** <20% of forests comprised of mature forest habitat (100+ yr old trees)

**Fair:** >20-50% of forests comprised of mature forest habitat (100+ yr old trees)

**Good:** 50-60% of forests comprised of mature forest habitat (100+ yr old trees)

**Very Good:** >60% of forest comprised of mature forest habitat (100+ yr old trees)

<sup>14</sup> Bushman, E.S. and G.D. Therres. 1988. Habitat Management Guidelines for Forest Interior Breeding Birds of Coastal Maryland. Wildlife Technical Publication 88-1. MD DNR, Forest, Park, and Wildlife services. 50pp.

dominance, which is an indicator of its own, addressed in the next section.)<sup>15</sup> Figure 8 summarizes the thresholds developed for this indicator, based on science team expertise

Unfortunately, the information currently available for forest maturity in the Corridor is, at this point, spotty and not in a format that allows it to be analyzed in total. This situation will improve with the conversion of Natural Heritage Program forest characterizations and Delaware Forest Service forest management plans to a digital format (currently underway), but there will likely still be gaps where no surveys or management plans have been completed.

The only known attempt at taking a comprehensive look at forest maturity for the Corridor has been the digitization of forests from aerial photographs from 1937. This digitization was completed recently by DNREC Natural Areas Program and visually cross-checked against 1960's aerial photographs by TNC's GIS contractor. Identifying those forests present in 1937, in the 1960's, and still present today, provides an idea of where there are mature forests today -- at least 65 years old, and likely older Map P. However these results indicate that upwards of 60% of the Corridor is relatively mature -- a figure Science Team experts believe is unrealistically high, but that could be revised or refuted when better characterization data is available.

In the meantime, Blackbird State Forester Jim Dobson estimates that state forest lands include several hundred but less than 1,000 acres of mature forest, between 10 and 20% of the total. If we apply this to the Corridor, our indicator ratings rank current conditions for maturity in the Corridor as "Poor." Given the Corridor's history of clearing, timbering, and gypsy moth destruction, a poor ranking is not surprising. With little confidence in either this ball-park estimate or the 1937 aerial analysis results were not heavily reliant on these results to identify focus areas for Corridor conservation efforts.

## **Oak Dominance: An Indicator of Species Composition & Abundance**

A similar and related key ecological attribute is the abundance and composition of certain native species in Corridor forests. The higher quality forest habitats in the Corridor are those that have a diverse mix of dominant tree species that is typical to the area -- an oak-hickory mix characterized by oak dominance (at least 25% oak.) Regenerating areas of forest in the Corridor tend to establish with a Maple-Sweetgum mix that is otherwise relatively homogenous compared to the characteristic oak-hickory mix. Historically, fires set by Native Americans and early European settlers may have favored oak-hickory species regeneration. The apparent difficulty of local forests to naturally regenerate in oak is a concern because of the greater diversity of species supported by the oak-hickory mix. So, oak dominance is a desired characteristic around which indicator ratings were developed (Figure 9).

As with maturity, there are little comprehensive data for species dominance in the Corridor, leaving us to rely on expert estimates. Based on site visits in October, science team members estimate that a "significant" amount of forest - 30% or more -- has the

**Figure 9**

**Oak Dominance Indicator Ratings:**

**Poor:** <30% of forest comprised of oak dominated (25% or more) mixed hardwood stands

**Fair:** 30-50% of forest comprised of oak dominated (25% or more) mixed hardwood stands

**Good:** 51-70% of forest comprised of oak dominated (25% or more) mixed hardwood stands

**Very Good:** >70% of forest comprised of oak dominated (25% or more) mixed hardwood stands

<sup>15</sup> As better forest data becomes available, it may be useful to look at all or more of these characteristics separately.

characteristics of fair quality, where "fair quality" is based on 25% oak dominated canopy, among other things. Once again, the digitization of Natural Heritage Program forest characterizations and of Forest Management Plans could shed some additional light on this measure.

1937 aerial analysis may also be a tenuous indicator of lands that fall into the "fair" category, since that characterization was also made based on maturity of 75 years or more. However, there is not enough confidence in such insights to use this measure heavily for determining where to prioritize conservation. For now, an estimate of "Fair" is the most supported current rating for the Corridor.

## **Zonal Thickness: An Indicator of Forest Patch Size and Shape**

It is intuitive that a larger forest would have the ability to support more wildlife than a smaller forest would have. It has also become common knowledge among conservationists that shape matters -- forest patches with more interior area can support more and different species than forest patches with more edge. Interior nesting birds such as northern parula, black-and-white warbler, pileated woodpecker, and worm-eating warbler are particularly sensitive to this. (black-and-white warbler, pileated woodpecker, and worm-eating warbler have all been found in the Corridor; northern parula has not been found in the Corridor but should occur there.) This understanding led scientists to identify forest patch size/shape as a key attribute for Corridor forests.

Traditionally, forest interior area has been measured by taking total patch size and subtracting a certain area (100 or 200 meters) from the edges. However, this methodology does not account for the fact that the remaining "interior" area may be long and thin in shape and not of optimal habitat value. Measuring zonal thickness is a more accurate way of determining true interior forest. Zonal thickness measures (via GIS analysis) the maximum depth of a forest patch and can be thought of as the radius of the largest circle that will fit entirely within a forest patch. This methodology has been found to provide a relatively accurate measure of forest interior area that has been correlated with on-the-ground observations of species. The zonal thickness thresholds shown in Figure 10 were developed for area sensitive species in consultation with Robbins, whose 1989 study provides references for minimum area for breeding for certain species (Figure 11).<sup>16</sup>

### **Figure 11**

#### **Robbins Results for Zonal Thickness**

Northern parula ZT >= 1,297 m (520 hectares/1285 acres)  
Black-and-white warbler ZT >= 846 m (220 hectares/544 acres)  
Pileated woodpecker ZT >= 725 m (165 hectares/408 acres)  
Worm-eating warbler ZT >= 698 m (150 hectares/371 acres)

### **Figure 10**

#### **Zonal Thickness Indicator Ratings:**

**Poor:** >15,000 acres with ZT < 698 meters  
**Fair:** >15,000 acres with ZT >698 m meters  
**Good:** >15,000 acres comprised of forest patches with ZT >725 meters or  
**Very Good:** >15,000 acres comprised of forest patches with ZT 1297 meters or greater

Rick McCorkle, of the USFWS Delaware Bay Estuary Project, conducted the GIS analysis to calculate zonal thickness values for each forest patch in the Corridor using the same forest data used for patch isolation analysis. Unfortunately, the results indicate that all forest patches in the Corridor fall in the "Poor" category, with less than 698 meters of zonal thickness. Given the fragmentation and small patch

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<sup>16</sup> Robbins et.al. 1989

sizes occurring in the Corridor, the result was not necessarily a surprise. However, it was enough of a disappointment to stimulate some additional investigation into the results, especially since Robbins indicator species like black and white warbler and pileated woodpecker are known to occur in the Corridor.<sup>17</sup>

Further investigation with Core Science team members brought to light a couple of possible reasons for skewed results, including data resolution. By using higher resolution aerial data for the analysis than was used by Robbins et. al. in establishing species tolerances may have skewed the results toward lower quality. Since higher resolution detects more fragmentation, forests in the Corridor could actually have better zonal thickness than analysis results indicate, relative to the tolerances established by Robbins.

Of course, there are also other possible explanations for the occurrence of indicator species where Robbins-based measures say there is insufficient zonal thickness to support them: they could be nesting in fragments that are somewhat "marginal" in size for them because the fragments are relatively close to one another<sup>18</sup>, or they may not be successfully breeding.<sup>19</sup> However, empirical data collected from the Corridor provide reason for optimism: the Natural Heritage Program relative index shows that black-and-white warbler occurs in approximately 16.5% of forests in the Blackbird State Forest and pileated woodpecker occurs in 10% of corridor forests.<sup>20</sup>

Given a variety of possible explanations for these results, it did not seem wise to tinker with Robbins-based measures to better fit Corridor empirical results. However, the possibility that Corridor forests are better in this regard than the analysis indicated should be noted. Also, patch isolation analysis results should be used *in combination with* other forest indicator results and actual species occurrence to prioritize forest areas in the Corridor. (See the *Conservation Objectives and Priorities* section of this report.) To help guide these prioritization efforts different gradients of "poor" were mapped and it was discovered that over 9,000 acres of Corridor forests have 600 meters of zonal thickness, or more (Map Q.) For the near term at least, those acres represent the highest quality of forests, *in terms of zonal thickness*.

### ***Threats to Healthy Mixed Hardwood Coastal Matrix Forests***

The primary stresses to Corridor forests are habitat loss and fragmentation, which results in less connectivity and smaller patch size – two critical attributes for forest viability. A secondary, but significant stress to forests is species composition/abundance, especially the change in forest community

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<sup>17</sup> Indicator species black and white warbler and pileated woodpecker were observed in most of the Blackbird State Forest tracts surveyed by the DNREC Natural Heritage Program (per Kitt Heckscher).

<sup>18</sup> Researchers in New York state found that wood thrush nest success did not differ between edge nests and interior forested nests in "contiguous" landscapes (ie where mostly forested and not fragmented); whereas in fragmented landscapes survival was higher in interior than along edges. Driscoll, M.J.L. and T.M.Donovan. 2004. Landscape context moderates edge effects: nesting success of wood thrushes in Central New York. *Conservation Biology*, Volume 18, Number 5, pages 1330-1338.

<sup>19</sup> Email communication with Rick McCorkle of USFWS 2004-2005.

<sup>20</sup> Email communication with Christopher Heckscher of the Delaware Natural Heritage Program January 2005.



composition (from oak dominant to maple/sweetgum dominant) that has resulted from clear cutting, gypsy moth infestation in the late 1980's and early 1990's, and preclusion of fire.<sup>21</sup>

There are a variety of sources, or causes, of stress to forests. The impacts of these sources on key forest attributes and on forests as a whole, are summarized in Figure 12 (next page.) Analysis results show that Residential/commercial development and road construction/upgrades (and the development they encourage) pose the greatest threat to the health and sustainability of Corridor forests.

**Figure 12**

Threats - Sources of Stress			Species Composition/ Abundance	Connectivity - Animal Travel Habitat Continuity	Age class structure	patch size	Threat to System Rank
<b>Mixed Hardwood Coastal Matrix Forest</b>			<b>Medium</b>	<b>High</b>	<b>Low</b>	<b>High</b>	
1	Residential/commercial development	Contribution	High	Very High	-	High	High
		Irreversibility	Very High	Very High	-	Very High	
		Override					
		Source	High	Very High	-	High	
		Combined Rank	Medium	High	-	High	
2	Unsustainable/incompatible forestry practices	Contribution	Very High	Medium	Very High	Medium	Medium
		Irreversibility	Low	Low	Low	Low	
		Override					
		Source	High	Low	High	Low	
		Combined Rank	Medium	Low	Low	Low	
3	Invasive/alien species	Contribution	Low	Low			Medium
		Irreversibility	High	High			
		Override					
		Source	Medium	Medium	-	-	
		Combined Rank	Low	Medium	-	-	
4	Incompatible agricultural practices	Contribution	Low	High		Very High	High
		Irreversibility	Low	Low		Low	
		Override					
		Source	Low	Medium	-	High	
		Combined Rank	Low	Medium	-	High	
5	Road construction/upgrades	Contribution	Low	Medium		Medium	High
		Irreversibility	Very High	Very High		Very High	
		Override					
		Source	Medium	High	-	High	
		Combined Rank	Low	High	-	High	

Development (residential and commercial), incompatible agricultural practices (including clearing), and road construction/upgrades are the sources causing the most stress to Corridor forest, because of the habitat fragmentation and loss they cause. While development is less pervasive than agriculture in the

<sup>21</sup> Repeated defoliation from gypsy moths combined with droughts led to the mortality of a large percentage of oaks; many landowners, including the Delaware Forest Service, harvested dead/dying tress in an attempt to salvage the timber and derive some income. Many studies have shown that a preclusion of low intensity, prescribed fires has also led to increased regeneration of maple/gum and reduce regeneration of oaks. The Delaware Forest Service is beginning to offer prescribed fires to the public (at a fee); however, are limited as to where they can be offered due to the amount of neighboring developed land. Source: email communication with Austin Short, Delaware State Forester, January 2005.



Corridor today, growth pressures and rising land values suggest that conversion of forests (and agricultural land) for development is an increasing threat. Developed areas are also more difficult for some species to utilize and/or pass through, and development is a more permanent barrier than agriculture.

Road construction/upgrades have played a significant fragmenting role on Corridor forest in the past (Route 1), creating greater barriers to animal travel and habitat continuity. And they will continue to pose a threat as population increases put greater demands on local roads and for improvements (such as ramps) to the major roads in the Corridor, destroying and fragmenting habitat and increasing development pressure in the Corridor. Roads are also one of the most irreversible of threats.

Invasive non-native species and unsustainable/incompatible forestry practices -- including clear cuts, even-aged management, and clearing of snags and coarse woody debris -- stress forests to a lesser degree, primarily by changing the species mix and age-class structure of forests. However, the threat of alien invasive species on forests in the Corridor may have been underestimated by not specifically/fully taking into account the effect of gypsy moth infestation on species composition and abundance.<sup>22</sup> As discussed previously, the regeneration of affected areas in Red maple and Sweet gum trees is a concern, as it thwarts the growth of a more diverse oak-dominated mix of hardwoods.

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<sup>22</sup> State Forester Austin Short suggests that the threat of invasive species be elevated to “high” to take into account the gypsy moth impact on species composition, per email communication January 2005.